MODELLING MINERAL DUST EMISSION OVER NORTH AFRICA AND MIDDLE EAST USING AN HIGH-RESOLUTION SURFACE PROPERTIES FROM SATELLITE RETRIEVALS

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OBJECTIVE

Implement and test the impact of the drag partition correction in the emission scheme of the **NMMB/BSC-Dust** model using the aerodynamic roughness length from **ASCAT/PARASOL**.

INTRODUCTION

The threshol friction velocity (u_{*th}) is defined as the velocity above which soil particles begin to move in saltation flux:

Threshold friction velocity over smooth surface and D_p the diameter of soil particles

$$u_{*thr}(D_p, z_0, w) = \frac{u_{*dry}(D_p)}{R(z_0, z_{0s})} H(w)$$

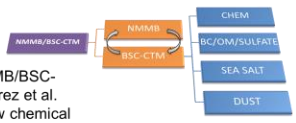
Moisture correction is introduced to account for the supression of soil erosion in wet soils

Drag partition correction
z_0: roughness length
z_{0s}: roughness length over smooth surfaces

The ***drag partition correction (R)*** accounts for the presence of nonerodible roughness elements (rocks, pebble, vegetation, etc.) in natural land surfaces. Aeolian aerodynamic roughness length (z_0) in arid regions is a key parameter to predict the vulnerability of the surface to wind erosion and the related production of mineral aerosol.

TOOLS

NMMB/BSC-Dust



The **NMMB/BSC-Dust** model is a part of the NMMB/BSC-Chemical Transport Model (NMMB/BSC-CTM; Pérez et al. 2011; Jorba et al., 2012; Spada et al., 2013) a new chemical weather prediction system. Its main features are:

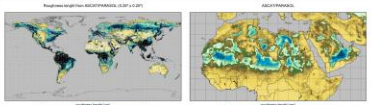
- *It allows working in global and regional configuration*
- *A physically emission scheme, which includes saltation and sandblasting*
- *8 bins externally mixed*
- *Wet removal in-cloud and below-cloud scavenging*

The **NMMB/BSC-Dust** provides operational daily dust forecasts at regional and global domains and participates in:

- **WMO SDS-WAS NAMEE Regional Center activies** http://sds-was.aemet.es/
- **Barcelona Dust Forecast Center** http://dust.aemet.es/
- **The ICAP global-model intercomparison project** http://www.nrlmry.navy.mil/aerosol/icap.3087.php
- **The Charmex Chemistry-Aerosol Mediterranean experiment**
- **The AQMEII on-line Air Quality model intercomparison project**

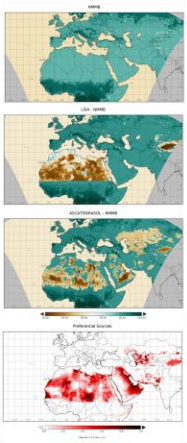
ASCAT/PARASOL

Satellite-derived roughness length at the global scale have emerged and provide the opportunity to use them in advanced emission schemes. A global map of the aeolian aerodynamic roughness length at high resolution is derived, for arid and semi-arid regions merging PARASOL and ASCAT data (Prigent et al., 2012).



- *Z_0 derived from ASCAT backscattering (1999-2009) and PARASOL 865 nm (2005-2008)*
- *Spatial resolution: ~ 6km x 6km (1/100º x 1/18º)*
- *Valid range: 0 - 0.08 cm. They are calculated outside this range but their validity is questionable.*

1. SENSITIVITY EXPERIMENTS

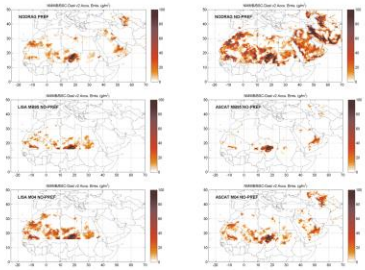


- *The simpler default option of the atmospheric model **NCEP-NMMB** applies a constant z_0 over desert regions (z_0 = 0.1001m)*
- *To asses the validity of the **ASCAT/PARASOL** data, results is compared with those obtained with **LISA** dataset (Laurent et al., 2005) which provides an estimate of z_0 at 0.25ºx0.25º spatial resolution for arid and semi-arid areas of Africa and Asia.*
- *Additionally, two different approaches to account for the **drag partition correction (R)** been tested: Marticorena and Bergametti (1995; referred as **MB95**) and MacKinnon et al. (2004; referred as **M04**).*
- *They are compared with the operational model version that no includes the drag partition correction and includes a topographical preferential source mask from Ginoux et al. (2001) (referred as **NO-DRAG**)*

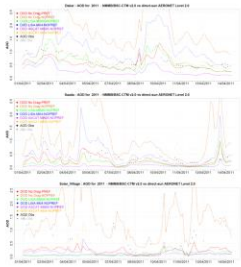
MODEL CONFIGURATION
Temporal period: 26th March to 19th April 2011
Regional domain: 31ºW-71ºE and 0º-70ºN
Spatial resolution: 0.25º x 0.25º x 24 layers
Fundamental time step: 40s
Cold start without data assimilation
Initial conditions from NCEP/FNL meteorological analysis (1ºx1º) at 0UTC and boundary conditions every 6 h

RESULTS: 26th March to 19th April 2011

Accumulated emissions (g/m²) from 26th March to 19th April

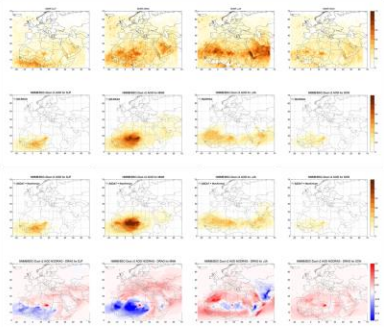


AERONET Level 2.0 comparison



2. ANNUAL MODEL EVALUTION

Seasonal averages for 2011



MODEL CONFIGURATION
Temporal period: 2011
Regional domain: 31ºW-71ºE and 0º-70ºN
Spatial resolution: 0.25º x 0.25º x 40 layers
Fundamental time step: 40s
Cold start without data assimilation
Initial conditions from NCEP/FNL meteorological analysis (1ºx1º) at 0UTC and boundary conditions every 6 h444

Both model configurations, DRAG (ASCAT/PARASOL-M04) and NO-DRAG, reproduces the seasonal evolution observed also in MISR.

- *In summer, low AOD values in both versions are linked to the initial meteorological fields from NCEP/FNL*
- *DRAG provides higher AOD values over the Sahara-Sahel region as well as Middle East. On the contrary, in NW. Africa NO-DRAG shows higher AOD values because the impact of the NMMB roughness length.*

AERONET comparison for 2011

- 49 stations distributed in 9 regions
- Filter applied to the AERONET observations
  - AE < 0.75 is considered in the calculations
  - AE >= 1.2 we assign AOD observe = 0

Regions	NDATA	REG NO-DRAG			REG DRAG ASCAT/PARASOL M04		
		r	RMSE	MB	r	RMSE	MB
Sahara-Sahel	3337	0,56	0,36	-0,05	0,49	0,52	0,04
E.Trop.N.Atl	2218	0,70	0,26	-0,17	0,58	0,32	-0,14
E.sub-Trop.N.Atl	1274	0,72	0,19	-0,12	0,62	0,22	-0,14
NW. Africa	2254	0,76	0,10	-0,05	0,70	0,12	-0,06
W/P	4941	0,76	0,09	-0,03	0,73	0,10	-0,04
E.P-W.Med	4971	0,69	0,07	-0,01	0,63	0,07	-0,02
C. Med	5595	0,67	0,08	-0,01	0,54	0,10	-0,02
E. Med	4176	0,54	0,12	-0,01	0,53	0,12	-0,03
West Asia	1240	0,37	0,43	-0,30	0,29	0,49	-0,34
NAMEE	29446	0,75	0,19	-0,05	0,66	0,24	-0,05

CONCLUSIONS

This contribution shows the analysis of the impact of the drag partition correction in the emission scheme of the NMMB/BSC-Dust model using the aerodynamic roughness length from ASCAT/PARASOL. These previous results highlight:

- *Over Sahara, the results from ASCAT/PARASOL are comparable to LISA. Moreover, the high minimum value of the NMMB roughness length (at z_0 = 0.1001m) I inhibits dust emissions.*
- *M04 provides higher emissions than MB95 as expected. M04 modified MB95 to accommodate the higher roughness length in the case of vegetated surfaces.*
- *DRAG (ASCAT/PARASOL-M04) provides higher AOD values than NO-DRAG in winter and spring in the Sahara. Otherwise, in NW. Africa , AOD fields are lower with DRAG (ASCAT/PARASOL-M04) than NO-DRAG. This is due to the impact of the NMMB roughness length in this region.*
- *In the AERONET annual comparison, NO-DRAG shows slightly better skill scores than DRAG. However, both model configurations present similar tendencies in the different regions analysed.*

Ongoing simulations at different spatial resolutions and with a refined roughness length map are under analysis.

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